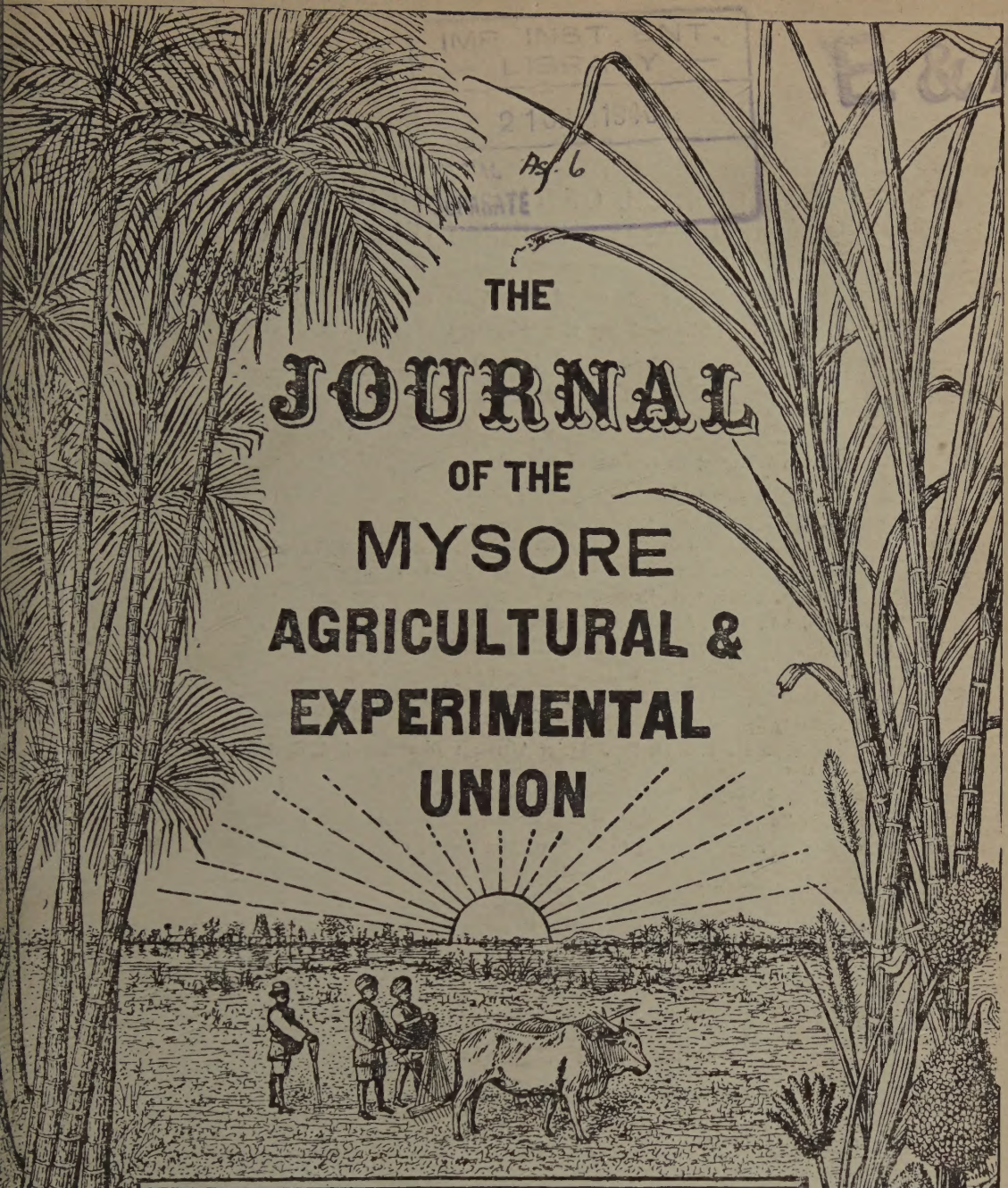

THE JOURNAL OF THE MYSORE AGRICULTURAL & EXPERIMENTAL UNION

Vol. XIX] JAN.—MAR. 1941 [No. 3

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A Note on Cotton Cultivation in the Irwin Canal Area as an Irrigated Crop—
By Dr. B. Dasappa, B.A., B.Ag., Ph.D., D.I.C., A.I.C.

The Light-Earthing-Up Technique for Control of the Sugarcane Dead-Heart Borer—
By B. V. Venkatacharya, B.Sc. (Agri.)

THE JOURNAL OF THE MYSORE AGRICULTURAL AND EXPERIMENTAL UNION

A quarterly magazine devoted to the advancement of Agriculture and published by the Mysore Agricultural and Experimental Union

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NOTICE

Members and Subscribers are requested to intimate promptly to the Union Office change of their address, as otherwise, letters and journals sent to them are likely to be delayed or missed altogether.

The Journal
of the
Mysore Agricultural
and
Experimental Union

Vol. XIX] JAN.—MAR. 1941 [No. 3

Editorial

A happy event to remember as this issue of the *Journal* goes to the Press is the visit of His Highness Sri Jayachamaraja Wodeyar to the Mysore Coffee Experiment Station, Balehonnur, on 16th February 1941, during his tour in the *malnad* districts. All of us have read day by day in the papers the keen interest taken by His Highness in agriculture in relation to the rural welfare of the *malnad*. It may be remembered that His late Highness Sir Sri Krishnaraja Wodeyar opened the laboratories on the Coffee Farm in 1931.

The Coffee Market Expansion Board that came into being as a result of an ordinance introduced by the Government of India in December 1940, has taken up the work in earnest. The control over the trade consists in the compulsory registration of all estates with over 25 acres of coffee, the division of the crops of estates into an internal quota of 40 per cent. for sales in India and a surplus pool of 60 per cent. for export by the Coffee Control Committee and the levy of an export duty of Re. 1 per cwt. on all exportable coffee, *i.e.*, the surplus pool and an excise duty of Re. 1 per cwt. on the internal quota. It is expected that an

organisation like this will stabilise prices and help the coffee industry.

Paddy cultivation in Mysore has received recently the attention that is long overdue. There has always been a large deficit of this commodity in the State to the value of Rs. 60 to 100 lakhs in spite of the vast scope there is for improving the yields. In order to distribute selected seeds of varieties evolved at the Paddy Breeding Station, Nagenhally, as widely among the raiyats as possible, a special staff of twenty-one Agricultural Inspectors has now been employed. They will acquaint the raiyats with all the improvements suggested by the Agricultural Department. A five-year plan of work concentrated in the large paddy areas is expected to increase the output of paddy. Growing a *palla* of paddy more per acre in the State with the improved varieties is a more sensible way of increasing production than extending the area under paddy.

The encouraging result obtained on the Irwin Canal Farm with growing long staple cotton under irrigated conditions has set our Director of Agriculture thinking about our present position of cotton in the State and its possibilities. In view of the fact that the cotton grown on the Irwin Canal Farm has found favour with the local mills, and that a market to the value of 40 to 50 lakhs of rupees worth of goods is assured, a Cotton Development Committee comprising of the Director of Agriculture, Superintending Engineer, Director of Industries and Commerce, and the Director and Mill Manager of the Bangalore Woollen, Cotton and Silk Mills, and of the Manager of the Bangalore Spinning Mills, was formed with the result that a scheme for a large-scale cultivation of cotton in Maddur and Malavalli Taluks has been sanctioned by Government and is already under way.

The various agricultural colonisation schemes started in India do not evoke happy memories in our minds. The modest colony of 10, started six months ago in the Irwin Canal area, showed such a fair promise that arrangements are being made to start a second colony of twenty in the

same area. The benefit of colonisation is in this case extended to youngmen who are unable to pay a cash security of Rs. 1,000, the condition being that a security of property of double the value or Mysore Government securities of the same value or two eligible personal securities should be furnished by them for loans granted to them under the scheme. The management and conditions regarding interest on loans are the same as in the previous colony, but the amount of loan to be advanced to each colonist is restricted to Rs. 750. A suggestion is made that if the response is satisfactory, another similar colony may be started near Marconahally.

A Note on Cotton Cultivation in the Irwin Canal Area as an Irrigated Crop

BY

Dr. B. Dasappa, B.A., B.Ag., Ph.D., D.I.C., A.I.C.

Assistant Director of Agriculture, Bangalore

It is a common popular belief that cotton is purely a crop of the black-cotton-soil tracts like Chitaldrug. This impression is incorrect. *Sannahathi* or Asiatic cotton which gives only a small yield of medium staple cotton grows in the black soil areas. The superior cottons, giving high yield per acre with better spinning quality, known as American cottons or *Doddahathies* grow much better in red soil areas like Arsikere, Closepet, Mandya, etc. Of these *Doddahathies,* the two varieties mentioned above, *viz.,* M.A. II and Co. 4 (X 4383) are very well suited to red soil tracts in the Irwin Canal area. They can be grown as a dry, purely rainfed and an irrigated crop. As an irrigated crop the yeild will be more than double that of a dry crop.

Soil.—Any good red loam, for that matter, any soil on which a good crop of ragi can be raised is equally well suited to the above cottons also. The main precaution to be taken in the selection of soil is that it should be fertile, but not water logged and should be well drained. Alkaline soils are also not desirable.

Preparation of land.—The land should be ploughed twice or thrice, preferably with an iron mould board plough, putting in 10 to 15 cart loads of good farm yard manure or at least 4 to 5 cart loads of compost, harrowed and levelled. To put it in a nutshell, the preparation of land for cotton sowing is exactly the same as for ragi. It is important to remember that cotton responds well to organic manure and that the application of artificial fertilisers like ammonium sulphate is unnecessary and unprofitable.

Opening furrows with a marker for sowing

Irrigating the land before sowing

Sowing the seed in rows

Covering the land after sowing

Opening plough furrows for irrigation between the rows sown with seed

Irrigating the plot after sowing ; water is let in the newly opened plough furrows

Interculturing

Ragi and Cotton in the field of Mr. Syed Abdul Hyder, Kotipur, Closepet

As experiments on the Irwin Canal Farm have definitely given highest yields of cotton in the February and March plantings, the land should be prepared as detailed above not later than the middle of February. In view of the fact that water will be available in the canals at all times except in the closed seasons between 3rd January to 12th January and 23rd January to 1st February, the ryots should have no difficulty to get the land ready in time. It is important to note that delay beyond the middle of March in sowing will definitely reduce yields of cotton.

Preparation of Seed for Sowing

About 10 to 15 lbs. of seeds are sufficient for sowing an acre. The seed should be rubbed with a thin paste of cowdung and red earth to separate the fuzzy seeds adhering to one another so that they may pass through the drill easily.

Sowing.—Since the soil will be devoid of the required moisture for seeds to germinate in the months of February and March, it is necessary to irrigate the land before sowing. To attain this object a marker with heavy iron tynes fitted 3 feet apart should be worked. For irrigation channels open plough furrows 30 feet apart across the furrows made by the marker and get the land irrigated. After a couple of days when the soil just forms a crust in the furrows cotton should be drilled through a single tyned drill (ಸಡ್ಡೆ). About 10 to 15 lbs. of seed should be sown in an acre of land. Where labour is cheap and available, dibbling 2 to 3 seeds at each spot, 9 inches apart in the row is preferable. When sowing is complete a brush harrow or a light log of wood should be worked across so as to lightly cover the seeds and also compact the seed bed. Care should be taken that the seed is not buried more than an inch deep. Where dibbling is adopted, it would be good to put in a handful of manure at each hole before dibbling.

Irrigation.—If the sowing is attended to without losing the optimum moisture conditions in the soil after the first

irrigation, all the seeds sown ought to germinate with no gaps left. The seeds will germinate in four to five days after sowing or dibbling. In some patches the seeds may fail to germinate due to want of moisture. To ensure uniform germination, an irrigation for germinating the seeds may be necessary. The furrows in which seeds are sown should not be used for irrigation as a large number of seeds may get dislodged or they may fail to germinate on account of excessive moisture. These difficulties may be overcome by opening plough furrows in between the rows of sown seeds and these furrows used for irrigating the field after the sowing is over.

After the seeds germinate no irrigation should be given if the plants are found to be growing well and if there is enough moisture in the soil; when need for an irrigation is felt it should be given. One has to be guided in irrigation by the incidence of rainfall and soil condition. No general rule can be laid out for this, except that there should be no water logging at any stage, especially after sowing and in the seedling stage. Great care is necessary in irrigating cotton as over-irrigation is injurious to the crop.

After cultivation.—When the plants are a month old they should be thinned out leaving the distance between plants in the row about one foot. By this process weak and poor seedlings can be eliminated. While thinning, hand-weeding in the rows should also be resorted to. A second hand-weeding may be done later, if found necessary. After thinning, a *Chipkunte* should be worked. A *kunte* should be worked both ways after every irrigation or a shower of rain. After every interculturing the irrigation channels are to be made by means of a *kunte*.

Inter-cultivation.—Inter-cultivation is most important in cotton cultivation as the crop would suffer seriously if inter-cultivation is neglected. The first inter-cultivation should be given at the time of thinning, *i.e.*, when the crop is a month old. After a fortnight another inter-cultivation should be given. Thereafter, *i.e.*, after the second alteration ragi may be transplanted as indicated later in this note.

Inter-cropping with ragi.—There is another great advantage in the cultivation of cotton that it allows the taking of an inter-crop of ragi. Thus it is possible for the raiyat to grow his grain, fodder and a money crop simultaneously. In fields where cotton has been sown or dibbled 3 feet apart between the rows, sowing having been done in February–March, a crop of kar ragi (early ragi) can be taken in the interspace between cotton rows as cotton takes 4 to 4½ months to cover up the land. A short season ragi (K. 1) can be transplanted. Ragi nursery should be sown about a fortnight after the sowing or dibbling of cotton seed and seedlings 4 weeks of age should be transplanted in rows a foot apart in the cotton fields, the ragi transplants being ¾ of a foot apart in the row. By the time ragi is transplanted the weeding and the second interculturing of cotton should be finished. Care should be taken that the land is completely weeded before the ragi is transplanted. K. 1 ragi is expected to be harvested 12 weeks after transplanting. Thereafter cotton alone remains on the land and is expected to fill the spaces above the stubbles of the harvested ragi.

By the time cotton comes to the first picking, ragi will be harvested.

Picking.—If the cotton is sown in March, the pickings start by the end of July and continue till October. Picking should be done as and when a sufficient number of bolls burst in a field. If pickings are unduly delayed the cotton may shed and get soiled or get drenched in rain. Care should be taken to pick cotton as often as possible to prevent drenching by rain.

The best time for picking cotton is between sunrise and mid-day. Cotton should be picked clean. It is always advisable for every picker to have two bags with him, one to put in good and clean cotton and the other for shed or dirty cotton. It is very essential that cotton should be picked clean and dried and stored away from rats, as cotton nibbled by rats goes down in quality. It is always better not to mix the last pickings with earlier ones as the former will be

of lower quality. This finishes the cultivation of cotton within a period of 8 to 9 months. When the pickings become rare in October the land should be ploughed up and left fallow for three weeks for weathering. Thereafter sann-hemp should be sown at the end of November and the green manure ploughed in January. It is very important to grow green manure crop in the Irwin Canal area to retain fertility of the lands.

As an irrigated crop in the Irwin Canal area yields of 40 maunds of seed cotton per acre of the estimated value of Rs. 100 to 120 per acre have been obtained. As a dry crop in the Closepet Taluk, 15 to 20 maunds of kappas have been picked. In addition, the yield of irrigated K 1 ragi may be estimated at 10 pallas valued at Rs. 50 for grain and Rs. 10 for straw. Incidentally the dried stalks of cotton serve as a useful source of fuel. It is important to note that cotton stalks should not be left standing but should be pulled out and dried and burnt as fuel as otherwise there is serious danger of cotton boll-worms becoming a pest in the area.

The Jola Grasshopper or The Deccan Grasshopper (*Colemania sphenarides* Boliv.)

BY

T. V. Subramanyam, Dip. in Agri.

Entomologist, Department of Agriculture, Bangalore

This insect has been noticed to appear at regular intervals of once in 10 or 15 years as a serious pest of the cereal crops, *viz.*, jola (*Andropogon sorghum*), ragi (*Eleusine coracana*), sajje (*Pennisetum typhodeum*), navane (*Setaria italica*), etc., sown during the south-west monsoon rains in the north and north-western parts of the State. They were first noticed during 1909–1911, thirty-one years ago in Honnali and Chennagiri Taluks of Shimoga District and four taluks in Chitaldroog District. A second outbreak of the insects occurred during 1926–29, and a third in 1939, ten years later. A very interesting fact about the insects is that they occur in more or less identical areas where they were previously noticed and the greatest damage to the crops is caused during the third and fourth year of their appearance. Only traces of the insects are found during the fifth year and no trace of them thereafter, until a fresh outbreak occurs after a lapse of several years.

Another fact noticed, about the damage to crops by the insects is that the latter are not found in all the areas where food grains are grown in a village, but in isolated patches doing considerable damage. Thus only some raiyats in a village suffer serious losses and the absence of a joint action by all the raiyats in a village in controlling the insects has been found to be a very great handicap.

Now that the insects have appeared for the third time after an interval of 10 years and this year being the third year of their appearance, a very serious outbreak of the insects is anticipated soon after a few south-west monsoon showers of rains are received. Inspection of the grasshopper affected areas in the Chitaldroog and Shimoga Districts last year showed a fairly good number of insects doing a certain

amount of damage to ragi, jola, navane, etc., in the following villages:—

CHITALDROOG DISTRICT

(*a*) *Kasba Hobli*—
(1) Pandarhalli, (2) Janakonda, (3) Hullur, (4) Singapura and several adjacent villages.

(*b*) *Jagalur Taluk*—
(1) Uddeghatta, (2) Gollarhatti.

(*c*) *Davangere and Harihar Taluks*—
(1) Yuragunte, (2) Karur, (3) Averagula, (4) Dodbathi and some villages close to Harihar and Malebennur.

SHIMOGA DISTRICT

(*a*) *Honnali Taluk*—
(1) Hallalli, (2) Arabakatte, (3) Sunkadakatte, (4) Kundur, (5) Marikoppa and several other villages.

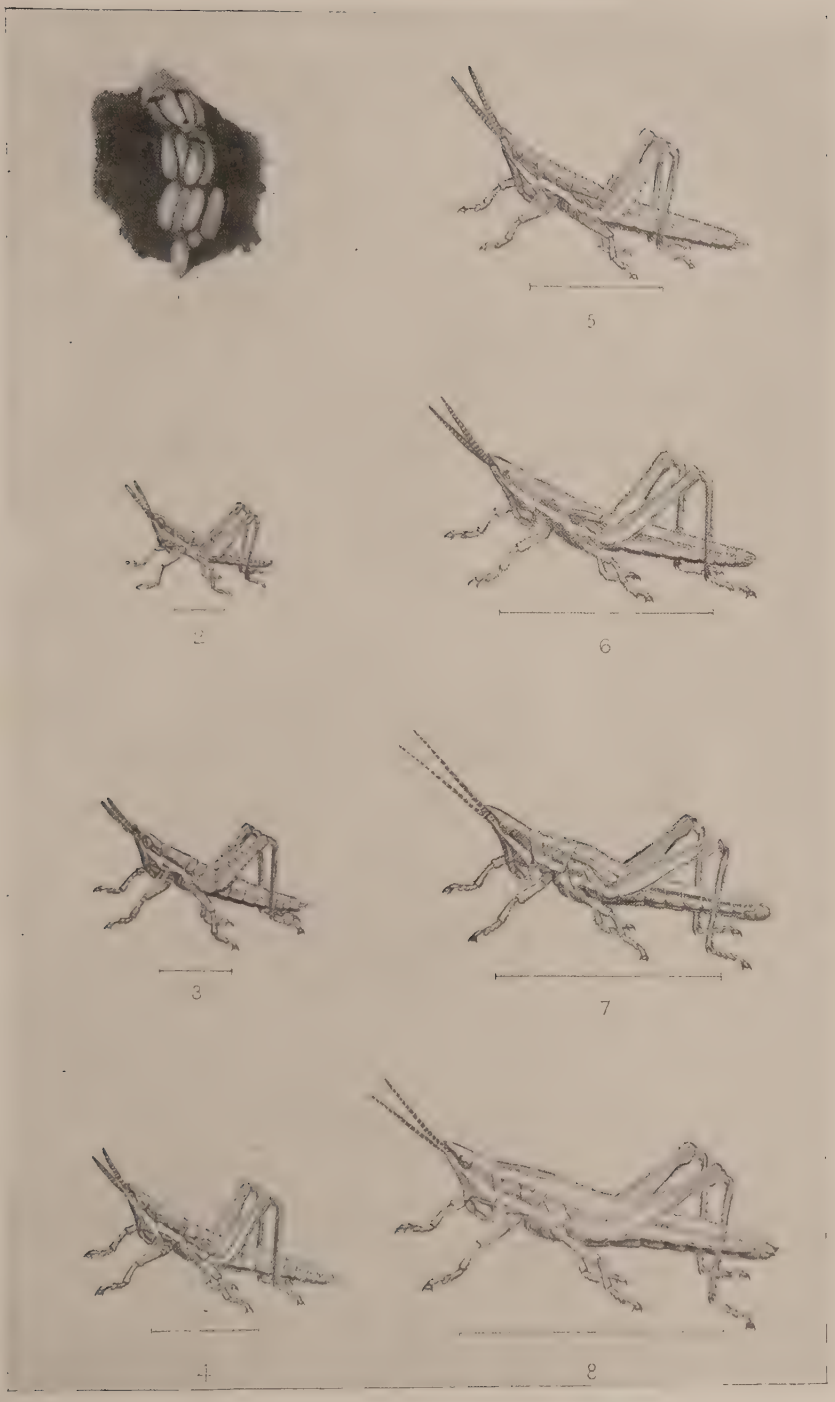
(*b*) *Chennagiri Taluk*—
(1) Hosahalli, (2) Devarhalli and a few adjacent villages.

As detailed description of the insects, their egg-laying and other habits and various control measures suggested, have been published in *Bulletin* No. 2, 1912, and Circular No. 43, 1926, of the Department, only the control measures that the raiyats should adopt during the early stages of the attack of their crop by the insects are mentioned in this publication.

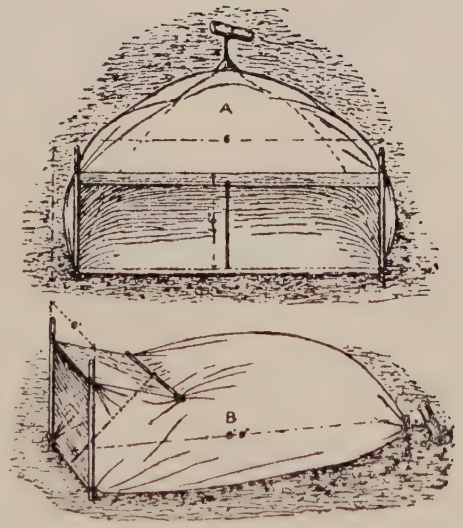
A careful study of the various aspects of the control of the insects made during the previous outbreaks has shown that the following methods, if adopted by the raiyats in the pest-infested areas, will go a great way in the control of the insects:—

34 207

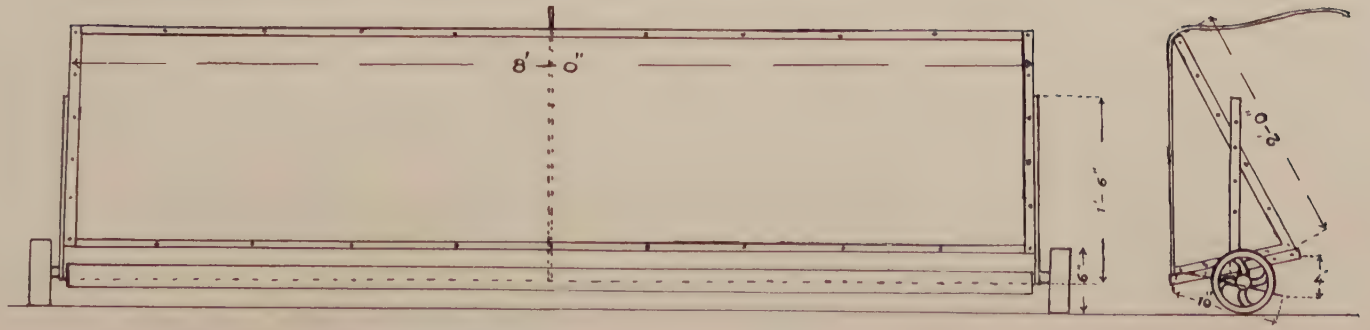
1. A grasshopper bag should be dragged quickly by two men, over the young jola or other crop on which the insects are found feeding in large numbers. By the use of the bags often, about four times, over a crop, a



Various stages of the Jola grass-hopper
1. eggs 8. the full-grown hopper



Grass-hopper bag



Measurements for the new contrivance to catch grass-hoppers

large number of insects are caught and these are destroyed by dropping them into a vessel containing water mixed with a little kerosene oil. This is a very cheap and efficient method within the means of a very poor cultivator, the cost of the bag being about a rupee. For an effective control of the pest by this method, co-operation and mutual help of the raiyats at least of those whose fields are affected in a village are very necessary.

2. A contrivance shown in the Figure was made and used during the fourth year of the appearance of the pest on the last occasion ten years ago and its work was satisfactory. This contrivance when dragged over the insect-infested crop by a pair of bullocks, the insects strike the vertical board of the machine and drop down to the bottom when they are caught in a bag. In the case of bagging where manual labour is used, bullocks are used here and insects over a very large area are caught in this case. The cost of the contrivance, about Rs. 30 each, is prohibitive for individual raiyats but the Village Panchayat funds in rich and prosperous villages could be easily utilised for making a few contrivances for the use of the village.

3. The young insects hatching out of the egg-masses during the south-west monsoon rains are found mostly confined to the grassy bunds between the fields, feeding on the grass for sometime. There is a great possibility of poisoning the young insects by the dusting of arsenical poisons like calcium arsenate or Paris green on the bunds and reduce their number appreciably.

Anticipating a serious outbreak of the insects during the next south-west monsoon rains, the Agricultural Department are making arrangements to carry out a campaign against the pest in Shimoga and Chitaldroog Districts. Government have been pleased to sanction funds for the appointment of temporary field staff to help the raiyats in the pest-affected areas. It is hoped that the raiyats will fully co-operate with the Agricultural Department in the control of the pest this year.

The Light-Earthing-Up Technique for Control of the Sugarcane Dead-Heart Borer*

BY

B. V. Venkatacharya, B.Sc. (Agri.)

Inamdar, Alakere, Mandya Taluk

E.H.N.

The Borer in Brief

The worst enemy of the sugarcane in the Irwin Canal tract is the dead-heart borer. It causes damage soon after the third week of planting, *i.e.*, after the setts germinate and continues till the plantation is about six weeks old. A second attack of a little less intensity, occurs between the eighth and the ninth weeks. Almost every field in every village and every crop, whether the early planted one or the late planted, suffers from the ravages of this pest. The attack is worst in gravelly plots and in the crop planted in March and April. During the years 1934 and 1935, when the pest was very virulent the crop in a good number of holdings had to be completely pulled out and the plots replanted, if required. In many a holding, the borer determined the profit or the loss to the raiyat.

The Older Methods of Control not Convenient

In this tract where intensive agriculture is practised, the older measures of controlling the borer were found difficult to be adopted. The small growers could ill-afford to maintain a separate "borer control unit", and the others could not pay regular attention for want of enough labour strength.

In the "catch-and-kill" method, it was found that careless handling of the shoots by the boys employed, blunt 'scalpels and probes' and want of optimum condition of moisture in the soil, were the factors which had to be contended against. As the shoots increased in numbers

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* *Argyria sticticraspis* Hmp. and *Diatroea venosata* Wlk.

with the age of the crop, the dead-hearts would increase also, requiring constant and systematic scrutiny by a separate establishment. The severe pruning of the shoots and the burrowing of soil round the stems at root range, weakened the future shoots also.

The 'egg-mass collection method' was devised to do away with the pest at a much earlier stage but it was too careful a work to be entrusted to the irresponsible boy labourers. The very tedious work of continuously bending down hours together at the plants, searching the leaf-sheaths and the backs of the leaf-blades, was sufficient to tire out even an honest workman frequently to the verge of carelessness. Then the young crop could not be inspected but once and left at that. Frequent vigilance was necessary to prevent the successive hatchings of egg-masses. As the crop advanced in age, the leaves to be searched would enormously multiply and render the method impracticable for the poor raiyat to employ.

The New but Simpler Method being more Effective

Of the various dead-heart borer control measures,[1] the cultural method suggested by the Agricultural Department[2] is the easiest, the cheapest and the most effective. "It consists in giving a light earthing-up to the young, four to five week-old plants by means of a light mould-board plough; and a good irrigation is given soon after making the loose heaped-up soil to settle down around the shoots", thus preventing the entry of the borer caterpillars into the tender portions of the stem causing damage. It is found by practical experience, that, if this method is taken up, soon after the setts germinate, no other measures like egg-mass collection or removal of first leaf-sheath need be done. This is a very simple method and could be used extensively and with great ease.

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1 "Sugarcane Borers and their Control in the Mysore State, *The Journal of the Mysore Agricultural and Experimental Union*, Vol. XIV, pp. 130–39.

2 *Ibid.*, Vol. XV, pp. 130–36.

It is proposed to discuss here the minute, but essential, details to be followed in successfully working out the method.

The Time of Operation

This method of control depends mostly on the promptness with which the earthing-up is done. It has been observed that the adult moth lays eggs on the shoots soon after germination and the eggs hatch into tiny borers in six to seven days, after which they begin to play havoc. If the light earthing-up be done *immediately after* the complete germination of the setts, the damage is prevented. In summer, when the cane setts germinate in 15 to 25 days, the crop should be earthed between 22 to 25 days. If planting is done during rainy season, the setts get a delayed start and the crop should be earthed up between the 28th and the 35th day after planting. In no case should one wait until a few dead-hearts appear.

Germination should be Uniform and Quick

Thus, it is essential that setts should be made to germinate all at one time. Most of the raiyats overlook the importance of quick germination, but wait for the weak shoots to emerge completely and then attend to the earthing. If, due to such defective germination, the earthing-up has to be postponed, though just for a few days, the pest gets a start on the early sprouted shoots, and the damage spreads like wild fire. The delay in quick and vigorous germination is overcome, if only, the following precautions are observed:

(i) The setts should be cut from a ten-month old sugarcane crop grown specially for the purpose.

(ii) Setts with roots, recently "bored" setts, setts containing bulged out, damaged, and scaly eye buds, should be rejected.

(iii) Setts should not be cut from a "grassy" stool.

(iv) In cutting top setts, the eye bud covered by the leaf-sheath[1] should not be included.

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[1] In letting labourers to cut setts strict supervision is necessary; and it is best not to have this piece of work done by contract, as is usually the case.

(v) Setts should be planted with a thin layer of earth covering them and the buds should face the sides.

(vi) The setts should not be sun-burnt, but should be planted immediately they are spread out on the field.

(vii) Since setts with leaf-sheath are not included (*vide* item iv), planting setts in a slanting position with a portion projecting above ground is also avoided.

(viii) After a rain, the rain-splashed and this exposed setts are to be covered with a thin layer of earth from the sides of the furrow.

The Light-Earthing-up

This consists of two parts:

(*a*) *The Hilling.*—As soon as all the setts germinate an optimum condition of moisture is provided and a worn-out country plough is worked, once on either side of the cane furrow, so that the loose earth is hilled up on the stems to a height of about an inch and a half. In light soils and soils which are loose in texture, the work is efficient. Thus for preparing the land for cane planting clods should be well crushed, otherwise, the clods hamper the good working of the plough, they fall upon the shoots and injure them and hilling is not done properly. Gravelly patches, ends of cane lines, and clayey areas are hand-worked by spade to finish the operation.

(*b*) *Providing facility for furrow irrigation which gets disturbed by hilling.*—The success of the light earthing-up, as a measure of borer control, depends upon the quickness with which the earthing is followed by irrigation, "to settle down the heaped soil" around the shoots. The above process disturbs the configuration of the land and the furrow irrigation which is being done till now, is not practicable at once. Therefore recourse is taken to flood irrigation, as an immediate cure and this is followed by working the *chipkutte* (tyned harrow) and the 18" blade harrow which disturbs the ridge completely and provides a shallow, but broad channel between plant lines for irrigating.

Raiyats often flood-irrigate their young fields from the

commencement of germination as a remedy for the borer but the ravages are not checked. As there is no rationale behind such action, it should be depracated, since it destroys the porosity and tilth of the soil, renders it compact necessitating frequent irrigation. The condition of the land after this leaves the crop pale, languid and weak.

In fact, the light-earthing-up and the subsequent blade harrowing maintains a porous mound of earth around the shoots, and the furrow irrigation keeps it up: this results in effecting a saving in the number of irrigations. A second earthing-up on similar lines should be done, about three weeks after this, to prevent the second attack of the borers.

The Merits of the Method

There is no gainsaying the fact that this method is an efficient check against the pest compared with the other older methods of control.

(1) This method has the advantage of being more a preventive than a curative one in action.

(2) After this method is practised, only 3 to 5 per cent. of attack is observed, under average conditions. In worst cases, however, about 25 per cent. of the shoots are affected. The secondary shoots arising after the operations are not troubled by the pest. But, in the absence of this method the extent of attack is nearly 100 per cent., as already indicated in the opening paragraph of this article.

(3) Since this is a cultural method, it leaves a clean field and saves one or two weedings and a few irrigations.

(4) It gives a light pruning to the young roots and encourages a vigorous growth, subsequently.

(5) It opens up the soil, provides aeration and offers a mellow soil for root penetration.

(6) It has an extensive application and could be practised by anybody, in any class of soil and season, the operation is fairly fool-proof, and a separate labour force is not necessary.

(7) It is a cheap method, involving no cost to the raiyat.

Demerits

(*a*) The one and the only objection raised against this method, is that it discourages tillering.

Tillering may be affected if the earthing-up is heavy; beyond that, the objection is not based on facts and is therefore untenable.

(*b*) In the rainy season, setts are planted on one side of the furrow instead of in the centre. If the country plough is worked, there is more earth on one side for the plough to negotiate; and on the other side, there being a hollow, the earthing-up is not complete. In such a contingency earthing-up has got to be rushed through by spade-work alone.

A Secondary Use of the Method

Since what was an original furrow would be made into a hill, this is the best time to apply bulky organic manures, *e.g.,* cattle manure and compost and get them covered in by the earthing-up. Thus, before the plough is worked, the full dose of cattle manure or compost could be spread evenly in the furrow. If powdered groundnut cake is included among the manures to be applied, one-third of the full dose is sprinkled uniformly on either side of the row of plants in the furrow. This application of organic manures makes the soil more porous, prevents excessive evaporation of moisture and gives a fillip to the young cane crop.

The second dose of sulphate of ammonia should be applied as a finishing touch to this method, after one or two irrigations to promote profuse tillering.

The light-earthing-up marks a definite stage in the life-history of the sugarcane and if the germination is good and the borer arrested by the above method, a bounteous harvest is vouchsafed, provided the other conditions of manuring, irrigation and drainage are satisfied and are properly attended to, thereafter.

Summary

The light-earthing-up method is an effective preventive against the dead-heart borer; it is cheap and could be applied to varying conditions. Its success depends upon the promptness with which it is carried out, after complete germination of setts. Precautions to be observed to secure a vigorous and quick germination are discussed. The merits and demerits of this method are also taken into account.

'A' Farm of S. 705 Paddy at Challakere

BY

K. Ramaswamy, B.A.

Pleader, Challakere

S. 705 paddy strain was first introduced in this area by the Department on a very small scale during the rainy season in the year 1939. The variety was found to come up well here and yielded considerably more of grain and straw per acre within four months from the date of sowing than the local *Halubbalu* variety of paddy. Thus I was impressed with the performance of this new strain of paddy under the local conditions here during the monsoon period. Later, the Department suggested that I might well undertake to conduct 'A' Farm in my lands here, assuring me that the new paddy strain could be grown in the locality both in summer and in the rainy season and that the duration of the crop is the same in both seasons. Hence I willingly undertook an 'A' Farm of the paddy in my lands here.

One suitable well prepared plot, 34 guntas in area, was selected and was sown broadcast with 50 seers of the germinated seeds on 22–12–1939, with the idea to transplant the excess of seedlings subsequently in a separate plot by thinning out in the thick patches. When the seedlings were 25 days old, the thick portions were thinned out and the seedlings thus got were transplanted in a separate plot.

The nature of soil of the 'A' Farm plot is clayey loam in type and was well tilled and manured with 15 cartloads of well rotten cattle manure. The previous crop raised was irrigated local ragi. Necessary care was bestowed in arranging for proper irrigation from the tank and timely hand weedings (thrice). The crop came up well to a height of 3½ feet, was in ears by the end of March and was ready for harvest in the middle week of April. The crop did not lodge nor there was shedding of grains. The crop was harvested on 24–4–1940. On threshing, it yielded 1,369

seers of grain and 7 cartloads of straw. This works out to 1,610 seers of grain and 8 cartloads of straw per acre.

One notable difference between the broadcast plot and the transplanted small plot, was in the growth and the yield of the crop. The transplanted crop grew to a height of 4 to 4¼ feet and the ears were more full with grains unlike those in the broadcast plot. Thus it can be said with certainty that transplanting pays well in the shape of more of straw and grain, which works out to not less than 20 pallas of grain and 8 cartloads of straw per acre on an average in my lands here.

The grains of paddy strain, S. 705 differ from those of the common *Bhangarkaddi* in that they are awnless and finer and a little more elongated than the latter. *Bhangarkaddi* grains are a little stouter but smaller in size than those of S. 705. This new strain can be grown in both the summer and the rainy seasons in these parts as suggested by the Department and it beats the local *Halubbalu* paddy, both with regard to yield of straw and of grain per acre and also with regard to the duration of the crop. The fact that this new strain comes to harvest two to three weeks earlier than the local *Halubbalu* paddy variety goes a long way in making it more agreeable in this tract of scanty and fluctuating annual rainfall, where most of our lot depends on the lift-well (*Kapile*) irrigation. The saving of time, labour and cost of production is considerable. In addition, there is a decided increase in the money returns per acre as the new strain fetches annas eight to annas twelve in the local market per palla of paddy more than the *Halubbalu* variety. Further, cattle relish the straw of this new strain better than that of the straw of the local *Halubbalu*.

Results from Demonstration Plots

Demonstration plots as explained in the previous issues of the *Journal* form a good link between the researches of the experimental farm and agricultural practice of the farmer. Every farmer who lays out a demonstration plot enlightens both himself and his neighbours regarding the improvements. A few results given by such farmers are tabulated below:

TABLE

Name of the farmer and village	Variety of crop tried	Yield per acre	Yield of the local variety as compared with it
		Ragi	
Mr. M. D. Shivappa, Malali Village, Mysore Range	K. 1	Grain 7 pallas Straw 7 cartloads	
,, Somasekhariah, Gyarahalli, Hassan Taluk ..	,,	Grain 600 seers (6 pallas) Straw 30 bundles	Gidda ragi grain 480 seers
,, Mari Gowda, Rajaghatta, Hassan Taluk ..	,,	Grain 640 seers	Lo al ragi grain 416 seers
,, Channe Gowda, Kasturvalli, Hassan Taluk ..	,,	Grain 648 seers Straw 36 bundles	Local ragi grain 428 seers, straw 20 bundles
,, Kempe Gowda, Patel, Doddakondagula Village, Hassan Taluk	,,	Grain 754 seers Straw 29 bundles	428 seers 21 bundles
,, Hanumanthe Gowda, Doddakondagula Village, Hassan Taluk	,,	Grain 614 seers Straw 20 bundles	427 seers 14 bundles
,, B. Narayana Gowda, Koravangala Village, Hassan Taluk ..	H. 22	Grain 634 seers Straw 22½ bundles	364 seer 14 bundles
,, Channiah, Kalankoplu, Arsikere Taluk ..	,,	Grain 534 seers	400 seers
,, Suryanaika, Duggalapura Village, Tarikere Taluk	,,	Grain 600 seers Straw 2 cartloads	450 seers 2 cartloads
,, Venkataramanappa, Mosale Village, Shantigrama, Hassan Taluk	K. 1	Grain 1,040 seers Straw 32 bundles	666 seers 24 bundles

.. Javaregowda, Mosale Village, Shantgirama, Hassan Taluk	K. 1	Grain 1,200 seers Straw 40 bundles	Local ragi grain 666 seers straw 24 bundles
.. Keshavachar, Sulibele Village, Hoskote Taluk..	K. 1	Grain 800 seers	
,, Munisamiah, Kamasandra Village, Hoskote Taluk	K. 1	Grain 600 seers	Local ragi grain 500 seers
,, Ramiah of the above Village	K. 1	Grain 1.000 seers	Local ragi grain 800 seers
,, Nanjundegowda, Chennarayapatna Village, Devanahalli Taluk	E.C. 593	Grain 600 seers	Local ragi grain 204 seers
,, Subrayappa, Hoskote	E.C. 593	Grain 600 seers	Local ragi grain 500 seers
,, Tammanna, Patel, Gopanhally Village, Challakere Taluk	E.S. 11	Grain 1,066 seers Straw 4 cartloads	Local Doddaragi grain 650 seers, straw 6 cartloads
	Paddy		
Mr. D. V. Ramanna, Chandakvadi Village, Chamarajanagar Taluk	S. 661	Grain 3,000 seers Straw 400 bundles	
,, Lakshmappa, Surnahalli Village, Holenarsipur Taluk	S. 661	Grain 14 pallas Straw 45 bundles	Local pady grain 12 pallas, straw 43 bundles
,, Nanjappa, Cholenhalli Village, Chennarayapatna Taluk	S. 139	Grain 15 pallas Straw 32 bundles	Local paddy grain 11 pallas, straw 21 bundles

TABLE—*Contd.*

Name of the farmer and village	Variety of crop tried	Yield per acre	Yield of the local variety as compared with it
	Cotton		
Mr. Siddappa, Hunusekatte Village, Sira Taluk ..	Sel. 69	16 maunds (md. = 28 lbs.)	Local cotton 10 maunds
,, Hanumappa, Gannaikanhalli, Challakere Taluk	C.N. 86	26 maunds	
,, Kasireddi Gangappa of the same village ..	C.N. 86	28 maunds	
,, S. Gurusiddappa, Babbur, Hiriyur	C.N. 86	18 maunds +17 maunds expected	
	Sugarcane		
Mr. Nandyanaika, Yelavu Village, Tarikere Taluk	H.M. 320	256 maunds jaggery	Local *Pattanatti* cane 160 maunds jaggery
,, D. Shankaranarayana Rao, Sira ..	H.M. 320	49 tons cane	
,, Subba Rao, Anale Village, Channarayapatna Taluk	H.M. 320	38 tons cane	Local cheni cane 24 tons
,, G. Munisamappa, Chennarayapatna Village, Devanahalli Taluk	H.M. 320	17·3 tons cane	Local 16 tons cane
,, Nanjundegowda of the above village ..	H.M. 320	54 tons cane	28 tons cane
,, Veeramuniappa, Devanahalli	H.M. 320	41 tons cane	27 tons cane

Mr. B. V. Pandit, Nanjangud	White variety	195 seers	
„ Lingappa, Kalale Village, Nanjangud Taluk ..	White variety	155 seers	
„ K. Rajagopal, Panjanhally Village, Gundlupet Taluk	White variety	140 seers	Black local 112 seers
„ Rangappa, Basavapur Village, Gundlupet Taluk	White variety	150 seers	Black local 120 seers

Crops manured according to the suggestions of the Agricultural Department

Name of the farmer and village	Yield under treatment per acre	Yield as locally obtained per acre
	Crop—Paddy	
Mr. Dattoji Rao, Haralur Village, Hoskote Taluk	Grain 1,600 seers	Grain 1,200 seers
,, Muniappa, Madahalli Village, Hoskote Taluk	Grain 1,600 seers	Grain 1,200 seers
,, Sharanappa, Davangere	Grain 14 pallas Straw 3 cartloads	Grain 10 pallas Straw 2 cart-loads
,, Bommegowda, Panjiganhalli, Sira Taluk	Grain 17 pallas Straw 50 bundles	Grain 15 pallas Straw 40 bundles
,, Rangegowda, Chikkanhalli, Sira Taluk	Grain 1,275 seers Straw 1,925 lbs.	Grain 974 seers Straw 1,440 lbs.
,, Bagooriah, Holenarsipur	Grain 24 pallas Straw 52 bundles	Grain 16 pallas Straw 40 bundles
,, Madegowda, Madegowdankoppalu, Chennarayapatna Taluk	Grain 18 pallas Straw 40 bundles	Grain 14 pallas Straw 30 bundles
	Crop—Sugarcane	
	H.M. 320	H.M. 320
,, B. Chandrayyar, Holenarsipur	28 tons cane	22 tons cane
,, I. Abdul Ghani, Belgod Village, Saklespur Taluk	364 maunds jaggery	217½ mds. jaggery
,, Nandyanaika, Yelavu Village, Tarikere Taluk	288 maunds jaggery	200 mds. jaggery

Standard Yields of Sugarcane

In order to find out exactly the yield of sugarcane in different parts of the State, certain crop-cutting experiments were conducted during 1938–39. Government have approved of the adoption, as the standard rate of sugarcane per acre in the several taluks of the State in future, of the average figures as shown in the statement given below, in their Order No. A.F. 5829–41 (1) 63–40–4, dated 10–2–1941.

Statement showing the crop cutting experiments conducted during the year 1938–39 in several taluks of the State and the actual average figures arrived at

District	No.	Taluk	Average for Taluk (tons per acre)	Average for District (tons per acre)
Bangalore	1	Bangalore ..	28·78	
	2	Anekal ..	34·20	
	3	Devanahalli ..	24·55	
	4	Nelamangala ..	30·71	
	5	Dodballapur ..	28·85	
	6	Closepet ..	27·76	
	7	Channapatna ..	18·20	
	8	Magadi ..	29·77	27·89
Mandya	9	Krishnarajapet ..	23·00	
	10	Nagamangala ..	26·22	
	11	Mandya ..	46·00	
	12	Maddur ..	40·00	36·30
Tumkur	13	Tumkur ..	24·09	
	14	Kortagere ..	29·67	
	15	Gubbi ..	23·30	
	16	Kunigal ..	46·57	
	17	Turuvekere ..	20·12	
	18	Sira ..	37·50	26·39
Chitaldrug	19	Davangere ..	20·43	
	20	Molakalmuru ..	20·54	
	21	Hiriyur ..	16·58	18·51
Kolar	22	Kolar ..	22·45	
	23	Malur ..	31·31	
	24	Bagepalli ..	29·20	
	25	Gudibanda ..	37·44	
	26	Goribidnur ..	24·41	
	27	Bowringpet ..	32·76	
	28	Mulbagal ..	26·78	
	29	Chickballapur ..	24·74	
	30	Sidlaghatta ..	32·00	
	31	Chintamani ..	24·50	
	32	Srinivaspur ..	51·22	30·75
Mysore	33	Nanjangud ..	18·00	
	34	Chamarajanagar ..	23·28	
	35	Heggadadevankote ..	28·07	25·47
Shimoga	36	Shimoga ..	19·02	
	37	Shikarpur ..	20·59	
	38	Sorab ..	19·31	
	39	Thirthahalli ..	45·00	
	40	Hosanagar ..	12·50	
	41	Channagiri ..	8·03	
	42	Honnali ..	28·85	19·57
Hassan	43	Hassan ..	32·26	
	44	Arkalgud ..	26·20	
	45	Holenarsipur ..	8·80	
	46	Channarayapatna ..	9·96	
	47	Alur Sub-Taluk ..	28·85	
	48	Belur ..	31·33	24·17
Kadur	49	Chikmagalur ..	25·60	
	50	Kadur ..	28·26	
	51	Tarikere ..	8·93	
	52	Koppa ..	23·22	
	53	Narasimharajapura ..	17·50	20·15

SELECTIONS

The Nutritive Value of Rice*

In addition to ignorance of the value of a sound diet, the domestic economy of many of the people of the Orient is such as to cause them to consider very seriously the cost of their daily food. Many people eat but only small quantities of other foods as supplements to rice and often these supplements are chosen on account of their being readily available at low cost. Rice is the staple food and famine denotes a shortage of rice rather than a lack of other foods such as fats, fruit, vegetables and meat. It may be realized therefore that unless the quality of the rice is optimal, there can be little or no opportunity of improving the nutrition of the majority of the people.

Nearly 90 per cent. of the rice is dry matter so that the addition of the cheaper foods such as fresh vegetables and fruit which seldom contain 10 per cent. dry matter is unlikely to correct gross dificiencies in the many physiological essentials such as protein, vitamins, lime and other mineral elements. Rice is frequently eaten after being polished. Scientific studies have so frequently centred round the connection between polished rice and the onset of beri-beri, that other deficiencies caused by polishing rice seem to have been lost sight of. The work to be described in this paper has been designed with a view to scrutinizing the whole situation. In cases which must be numerous in the countries of the East, where economic conditions cause people to live almost entirely upon rice these other deficiencies are of great importance.

Our experiments have consisted of comparisons between polished rice and unpolished rice which I have designated husked rice.

Husked rice is ordinary rice secured by the removal of the hard, fibrous outer coat of the paddy. No polishing whatever is carried out and the rice is brownish in colour. The particular rice with which I have worked was grown mostly in the Krian district of Malaya and obtained and husked by the Government Rice Mill at Bagan Serai. Although I have got my rice from this source, other varieties grown and husked elsewhere would be equally satisfactory provided the paddy itself was of high quality. In Australia for instance, I found that husked rice of good quality was readily available in the shops at a cost of about two-thirds the cost of polished rice.

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* By John Lewis Rosedale of the Biochemical Laboratory, King Edward VII College of Medicine, Singapore. Reprinted from the *Journal of the Malaya Branch British Medical Association,* Vol. 3, No. 3, December 1939.

TABLE I

A Comparison of the Chemical Analysis of Husked Rice with that of Polished Rice

	Husked Rice: per cent.	Polished Rice: per cent.
Moisture ..	13·25	12·2
Ash	1·03	0·8
Protein	8·38	5·9
Fat	1·94	0·4
Fibre	0·50	0·4
Carbohydrate ..	74·90	80·3
Cl	0·2863	0·048
P_2O_5	0·393	0·380
CaO	0·0927	0·014
Mg	0·0778	0·036
Na	0·0542	0·022
K_2O	0·1421	0·074
SO_4	0·0024	0·0038
Fe	0·003177	0·00102
Cu	2·3 *y* in 100 grams	1·3 *y* in 100 grams
Mn	15·7 *y* ,, ,, ,,	13·8 *y* ,, ,, ,,
I	3·88 *y* ,, ,, ,,	2·6 *y* ,, ,, ,,

The losses on polishing are:—

29% of the protein,
79% of the fat,
84% of the lime,
67% of the iron.

On the other hand the fibre is increased by only 2·5 per cent. so that the digestibility is unlikely to be impaired in this way. Husked rice has a high content of vitamin B, at least one-tenth that of dried yeast, while polished rice has none. In the experiments to be described in this paper, there have been numerous cases of paralysis among the animals receiving polished rice, although no case has appeared among the animals receiving husked rice.

The difference in the protein content between the two rices which is only about 2 grams in 100 grams of rice may not at first sight appear to be very large, but a calculation shows that it may be very important. Thus, a man who eats 21·4 ounces (2,200 calories) of husked rice would get 53 grams of protein, whereas by eating a similar quantity of polished rice he would get but 38 grams of protein. This really constitutes the difference between a minimum protein requirement and a sub-minimal amount or shortage of protein if the man eats the polished rice. It is usually conceded that the protein intake of the rice-eater is low, and the League of Nations Technical Commission has recommended 1 gram of protein per kg. of body

weight as satisfying the requirement. In a study of the basal metabolism of a number of subjects at Singapore, who must be considered as normally nourished people, Oliveiro (*Jour. Malaya Branch B.M.A.*, 1937) records 58·1 kg. as the average weight of these people. Thus 53 grams of protein goes far in securing the protein requirement. Some years ago I made an amino-acid analysis of the protein of rice (*Chem. Analyses of Malayan Foods*, Table II, p. 12) and found the following data:—

TABLE II

Analysis of Rice Protein

	%		%
Ammonia ..	6·5	Lysine N ..	8·9
Humin nitrogen ..	5·2	Mono-amino N ..	43·7
Total bases N ..	27·3	Cystine N ..	1·1
Arginine N ..	13·7	Tryptophan N ..	0·9
Histidine N ..	0·9		

These figures show that the protein of rice is of good quality among the cereals.

The mineral content of husked rice is 1·03 per cent. as against 0·8 per cent. in polished rice. With the exception of phosphorus and sulphur, each mineral element exists in greater proportion in husked rice than in polished rice. But little is known at present of the requirement of man in regard to many of the mineral elements, but in some countries where the supply of salt is likely to be difficult, it may be noticed that the amounts of both sodium and of chlorine are approximately double in husked rice of what they are in the polished rice. The iodine content is also distinctly superior in husked rice. During metabolism, much of the iodine which is eliminated appears in the urine, and it has been estimated that an adult requires an intake of half a milligram daily to replace the loss. If this is so, then our 2,200 calories of husked rice will supply half the need and the other half must be supplied by the supplementary foods. Reference to a table of analysis such as Table VI in *Chemical Analysis of Malayan Foods* shows that this can be done by choosing such supplements as *dhal*, mangosteen, pumelo, carrot, eggs, spinach, and various other common foods.

The experiments of Series IV below, show that a rice diet is improved by additional lime. Lime, therefore, must be considered a deficiency of polished rice, so that a rice which contains about eight times the quantity of lime that is contained in polished rice must be considered superior. A person taking 2,200 calories in the form of husked rice would receive 0·56 gram CaO, as against but 0·08 gram CaO if he ate polished rice. This amount (0·56 gm.) almost equals

the Sherman standard for adults and is about half the lime requirement demanded by Sherman for children, but the subject has already been discussed in a former paper from my laboratory (Morris and Oliveiro, *Mal. Med. Jour.*, 1933, Vol. 8, p. 236).

Sherman has also suggested that the iron requirement probably lies somewhere between 10–15 mgms. daily. The consumption of 2,200 calories of polished rice would lead to an intake of only 6 mgms. iron, whereas the same quantity of husked rice yields 19 mgms. iron. The copper content of husked rice is double that of polished rice. Since iron and copper have to do with the prevention and cure of some simple anæmias, it seems evident that the use of husked rice in the place of polished rice would diminish the large number of cases of anæmia.

While the copper content of husked rice is so superior to that of polished rice, Sherman has estimated the daily requirements as high as 2 mgms. This high figure is not secured by our 2,200 calories of husked rice, though polished rice approaches the requirement less closely. If this high requirement is finally decided upon as being optimal, supplementary foods such as green gram, pineapple, bamboo shoot, egg plant, ladies-fingers, and tamarind, will be found useful. I mention these points because the supplementary foods are of physiological importance even when husked rice forms the staple diet, and because the choice of foods is a very important point. If a standard rice of such excellent quality as husked rice were universally adopted, it might then be possible to guide the agricultural activities of a district in such a way as to enable the inhabitants to obtain those supplementary foods which would be of greatest physiological value to them at the lowest cost.

Another marked difference between these two types of rice lies in the fat content. More than three-quarters of the fat of rice disappears on polishing. It was interesting to notice, during the progress of the experiments of Series III and VI below in which the oil was removed from the basal diet, that more cases of paralysis occurred among the animals receiving the polished rice than in any of the other series. The fur of these animals became short, and many became bald. No cases of paralysis or baldness occurred among the animals receiving husked rice so that it appears that the higher fat content of husked rice was of some nutritional value.

It is of interest, therefore, to ascertain whether there is any difference between the fat of husked rice and that of polished rice. I have been unable to demonstrate the presence of vitamin A or of carotene in rice whether husked or polished. It is known, however, that carbohydrate is insufficiently burned in the body in the absence of

unsaturated fatty acids in the fat of the food. Table III shows the "iodine value" of polished rice, husked rice and rice polishings. It is evident that most of the unsaturated fatty acids in the fat of rice are lost by polishing, and this may well be serious in a diet, such as is taken by the average rice-eater, which is usually so high in its content of carbohydrate.

TABLE III

Iodine Values

Polished Rice	Husked Rice	Rice Polishings
11·5	43·6	85·16

EXPERIMENTAL

The experiments were based upon an old experiment carried out some years ago, in which polished rice had been used as the basal cereal; casein had been used as the source of protein after removal of the vitamin B by extraction, washing and autoclaving; red palm oil had been used to supply fat and vitamin A; calcium carbonate had also been added and marmite had been used as source of vitamin B.

The old diet had been

	grams
Polished rice	72
Casein	12
Red palm oil	5
Calcium carbonate	1
Marmite	5

This diet had enabled rapid growth in some female rats whose weight at 20 weeks became 252 grams each. It was desired, at the outset of these new experiments to see, whether by substituting husked rice for the polished rice of the above diet, the marmite could safely be omitted.

The original plan was to test the husked rice on the basal diet as it stood, and then to test it upon the same diet when the casein, or the red palm oil, or the lime, or any of these as well as the marmite had been left out of the original diet. While this plan was eventually carried out it was greatly extended by repetitions with various foods added as supplements. The reason for this extension was that rice is supplemented in ordinary diets and the possibility remained that in some cases other foods might perhaps supplement

polished rice so well that any superiority of the husked rice might perhaps not be as real as the experiments of the original plan might seem to indicate. Accordingly as wide a number of supplementary foods as possible were chosen, representative of types of food commonly eaten. The experiments show that no matter which type of food is chosen as supplement, the difference between husked rice and polished rice cannot be bridged by supplementary foods which are ordinarily available.

The supplementary foods chosen were potato, carrot, onion, kangkong, parsnip, leeks, cheese, banana, beef, beetroot, orange juice, apple, lobak, French beans, bacon, cabbage, cucumber, prunes, swede, and tomato. Eight different series of experiments were made, each in duplicate, one of the duplicates receiving polished rice and the other husked rice. The basal diet of each series was fed alone, and also with each of the supplementary foods separately. Thus each series consisted of 21 groups on polished rice, and 21 groups on husked rice, and each group consisted of four male and four female rats which were kept separately for the first twenty weeks of experiment and then mated. The experiments were started as soon after weaning as possible when the animals weighed 40 grams and they were weighed weekly during the first 20 weeks. Weighing was discontinued at mating time, but the litters were weighed at four weeks and again at eight weeks of age.

The supplementary foods were prepared as they might be prepared for human consumption; by boiling in the case of potato, carrot, onion, parsnip, leek, beef (after mincing), beetroot, lobak, French beans, cabbage and swede. Apple and prunes were stewed.

Bacon and tomato were fried in olive oil. The remainder were given uncooked. The amount of each supplement given was 3 grams per rat per day and the quantity of the basal diet was given to suit the requirements of the animals and was recorded. The basal diets of the eight series were:

TABLE IV

Series I. (*Full diet*)

					gm.
Polished rice	..	77 gm.	Husked rice	..	77
Casein ..	..	12	Casein ..	..	12
Red palm oil	..	5	Red palm oil	..	5
Calcium carb.	..	1	Calcium carb.	..	1

Series II. (*No casein*)

Polished rice	..	89 gm.	Husked rice	..	89
Red palm oil	..	5	Red palm oil	..	5
Calcium carb.	..	1	Calcium carb.	..	1

TABLE IV (*Contd.*)

Series III. (*No oil*)

					gm.
Polished rice	..	82 gm.	Husked rice	..	82
Casein ..	..	12	Casein ..	..	12
Calcium carb.	..	1	Calcium carb.	..	1

Series IV. (*No lime*)

Polished rice	..	78 gm.	Husked rice	..	78
Casein ..	..	12	Casein ..	..	12
Red palm oil	..	5	Red palm oil	..	5

Series V. (*No casein and no lime*)

Polished rice	..	90 gm.	Husked rice	..	90
Red palm oil	..	5	Red palm oil	..	5

Series VI. (*No casein and no oil*)

Polished rice	..	94 gm.	Husked rice	..	94
Calcium carb.	..	1	Calcium carb.	..	1

Series VII. (*No oil and no lime*)

Polished rice	..	83 gm.	Husked rice	..	83
Casein ..	..	12	Casein ..	..	12

Series VIII

Polished rice or husked rice only.

RESULTS

The death rates are shown in Table V.

Another method of assessing the difference in value between husked rice and polished rice is obtained from Table VI, which gives the amount of food of each diet required to produce 1 gram increase of body weight during the most active period of growth the first four weeks of experiment. In every case the husked rice diet has proved to be more economical than the corresponding diet containing polished rice.

TABLE V

Death rates

	Series I Full Diet		Series II F.D. less Casein		Series III F.D. less oil		Series IV F.D. less lime		Series V Rice % oil		Series VI Rice + Lime		Series VII Rice + Casein		Series VIII Rice only	
	P	H	P	H	P	H	P	H	P	H	P	H	P	H	P	H
Controls	1	0	4	8	8	5	8	4	8	6	8	6	8	7	7x	5
Potato	0	0	1	1	0	0	3	0	8	8	4x	0	5	2	8	6
Carrot	2	0	0	0	0	0	2	0	8	4	8x	1	4	0	8	4
Onion	0	0	2x	2	0	0	1x	1	5	2	8	1	3	2	7	2
Kangkong	0	1	2x	0	0	0	3x	0	4	0	8x	1	2	0	8	2
Parsnip	0	0	1	0	4x	0	2	0	7	2	3	0	6	0	5	2
Leeks	1x	0	2x	0	0	0	1	2	4x	2	4x	0	5	1	4	3
Cheese	2x	0	2x	0	2x	0	2x	2	4x	1	3x	0	5x	0	5x	1
Banana	0	0	1	1	2x	0	4	2	8	8	3x	0	7	2	7	5
Beef	1	1	7x	0	4x	0	8	4	8	8	5x	1	8	6	8x	6
Beetroot	1x	0	2	0	3x	1	3	1	7	6	0	1	7x	0	8	6
Orange	4x	0	5	0	4x	0	4x	3	8	6	3	2	7	2	1	3
Apple	1x	0	2	0	5x	2	5	1	8	8	1	1	8	4	5	7
Lobak	0	0	1x	0	8x	0	4	2	8	8	8	3	8	6	7	8
French beans ..	0	0	0	0	3x	3	1	3	8x	5	5x	0	8	1	8	3
Bacon	0	0	2	1	7x	1	8	7	8x	8	7	7	8	8	8	8
Cabbage	2x	1	0	0	2	0	5	1	7	2	7	2	8	4	8	4
Cucumber	0	0	1	0	2	1	3	2	8	8	5	1	6	4	8	5
Prunes	0	1	0	0	0	0	4	0	6	6	1	0	5	1	6	1
Swede	1x	1	3	1	2	0	4x	2	7	4	6x	0	3x	3	6	1
Tomato	0	0	1	0	2	0	5x	1	8	6	7x	0	8	2	7	6
	16	5	39	6	58	13	80	38	147	108	104	27	129	55	139	88

P = polished rice groups. H = husked rice groups x = paralysis.

Table VI

Grams of food intake to produce 1 gm. increase in body weight for first four weeks

	Series I		Series II		Series III		Series IV		Series V		Series VI		Series VII		Series VIII	
	P	H	P	H	P	H	P	H	P	H	P	H	P	H	P	H
Potato ..	11·6	8·0	13·0	8·3	13·5	6·1	26·7	12·6	37·7	21·2	23·6	7·2	20·7	11·2	43·7	12·5
Carrot ..	12·0	6·0	25·9	7·1	12·0	6·3	21·9	10·6	21·3	18·0	17·0	10·8	27·0	11·5	18·1	10·3
Onion ..	12·4	5·0	29·1	9·1	12·6	7·0	23·3	11·4	33·4	24·7	31·1	12·7	37·2	18·0	31·8	11·3
Kangkong	9·7	5·0	12·9	6·7	9·2	5·0	19·5	10·1	24·8	16·2	25·4	7·0	28·0	17·3	45·1	14·2
Parsnip ..	10·0	5·8	17·2	6·1	12·8	5·6	49·3	16·8	43·5	21·4	22·1	10·5	24·7	11·2	700·0	32·5
Leeks ..	10·0	6·9	18·9	6·9	11·1	5·7	22·6	17·3	26·0	16·1	32·3	12·1	29·4	15·0	63·6	19·4
Cheese ..	8·2	4·4	4·0	2·6	4·0	3·0	6·1	4·1	7·5	4·3	6·0	2·5	8·8	3·7	5·6	2·6
Banana ..	11·2	7·3	23·7	10·7	9·0	6·0	18·4	27·3	28·0	21·2	22·1	9·0	23·6	19·6	466·0	63·6
Beef ..	6·0	4·9	7·4	4·0	5·7	4·3	13·3	7·3	20·7	10·4	14·3	6·3	36·5	11·5	22·9	10·0
Beetroot ..	15·3	5·6	15·9	6·5	9·9	8·1	59·3	14·6	23·8	17·2	15·4	6·4	26·6	15·1	39·8	33·3
Orange ..	13·9	6·0	..	10·7	12·7	7·5	40·7	20·1	8·6	24·5	52·5	14·4	50·9	21·2	..	26·2
Apple ..	15·8	5·0	28·0	7·4	16·3	9·8	25·7	27·0	60·0	21·7	48·0	13·3	76·3	25·8	..	34·1
Lobak ..	9·0	4·4	20·5	9·2	13·3	7·8	31·5	21·0	29·4	17·4	17·7	7·3	36·7	11·5	35·0	18·9
French beans	9·0	4·2	19·1	9·2	11·5	6·5	19·8	12·9	25·5	13·0	21·2	8·7	22·4	10·7	60·8	12·8
Bacon ..	6·4	4·4	8·3	7·6	6·9	4·7	13·8	8·7	19·5	11·1	8·6	4·5	12·6	9·0	18·6	10·0
Cabbage ..	11·2	5·3	20·0	9·2	20·6	10·1	24·5	16·3	35·9	20·2	31·7	10·5	22·1	15·4	28·5	21·8
Cucumber ..	13·4	6·4	30·4	10·0	20·8	9·0	19·5	16·5	79·0	35·9	15·0	5·8	20·2	11·5	41·1	13·6
Prunes ..	11·7	5·2	13·4	8·2	20·1	7·0	126·5	26·5	102·3	30·0	19·3	7·6	56·0	28·0	116·6	37·8
Swede ..	9·4	7·0	33·9	9·0	19·2	10·0	59·3	18·4	31·0	14·6	17·3	7·0	29·4	12·6	52·2	17·3
Tomato ..	6·2	5·0	16·0	7·5	17·4	11·3	61·2	20·0	56·1	31·6	18·0	6·2	18·4	11·8	35·0	11·6
Control ..	23·3	8·0	41·6	13·3	25·8	13·3	39·5	26·6	54·8	31·9	40·9	10·7	32·3	11·4	82·3	22·5

P = polished rice groups H = husked rice groups

We may consider the groups in which no supplementary foods were given. These may be summarized as follows:—

Diet	Polished Rice Groups			Husked Rice Groups		
	Weight at 20 weeks		Deaths	Weight at 20 weeks		Deaths
	Males	Females		Males	Females	
	gm.	gm.		gm.	gm.	
Full ..	82	72	1	149	141	0
No casein ..	43	59	2	115	110	0
No oil ..	63	..	7	92	48	5
No lime ..	..	..	all	92	50	4
Oil + rice ..	..	..	all	87	..	6
Lime + rice ..	..	..	all	58	94	6
Casein + rice	..	..	all at 12 weeks	..	..	all at 16 weeks
Rice only ..	..	..	all	66	42	5

We may observe that no animal survived for 20 weeks on the polished rice diets except in the first three groups, and that some of the animals of the husked rice groups survived for this period except when rice and autoclaved casein constituted the diet.

In the first three groups where some animals lived for 20 weeks on the polished rice diets, the husked rice animals have grown to greater weight than the polished rice animals and the death rate has been greater in the polished rice groups.

In the third series, where the oil was omitted from the full diet, only one animal has survived the period of 20 weeks on polished rice. A certain amount of nervousness was noticed among the animals of this series, but the cause of death of the majority of those upon white rice, was paralysis. This was not observed in the husked rice group. While therefore the fat of the husked rice has not prevented signs of nervousness, it has prevented paralysis and baldness. The baldness was invariable among the animals of this series which received polished rice and was similar in appearance to that described by Burr and Burr (*Jour. Biol. Chem.*, 1929, Vol. 82, p. 345) among animals receiving too little amounts of fat of satisfactory fatty-acid content. Both these major symptoms have been prevented by the

use of husked rice which has a greater iodine value than that of polished rice.

When lime was omitted from the full diet none of the animals receiving polished rice survived, while the losses in the husked rice groups amounted to 50 per cent. It has been pointed out above that the husked rice supplies about half the lime requirement for growing animals demanded by the Sherman standard.

The results obtained from the different groups receiving the supplementary foods are various, and it is impossible to understand clearly all these differences until we know much more than we do at present about the supplementary foods themselves. To be able to account fully for all the differences would probably mean to know all that there is to know about foods. It may be said however that all the foods which have been benefited the basal diets have given better results in the diets which have contained husked rice than in those which have contained polished rice. One object of these experiments was to see whether we could find a food which would compensate for polishing the rice and we have failed to find such a food. Reference to the charts shows clearly that it is true to say that the organism receives greater benefit from a little bit of meat, or vegetable, or of fruit if it is taken with husked rice than when it is taken with polished rice. In other words, the poor man who can only afford but meagre supplements to his rice, will receive greater benefit from his small monetary outlay if his rice is not polished. It is clear that both in regard to the full diet (Series I) and in all the other series, several of which have known dietary deficiencies, that husked rice is definitely superior to polished rice as a food.

Although it may thus be proved that husked rice excels polished rice in physiological value, and in economy, it is another matter to secure its adoption by the people. In many villages and country districts the rice is not yet polished to an extent that makes any change necessary. It remains only for enlightened administration to see that a change to polished rice is prevented. This however is not true of the towns where people have grown accustomed to the polished article, the millers receiving extra profit from the offal which is sold as animal food. Thus such adoption is not exactly a simple physiological issue, since it involves the interests of the trade. One of the supposed advantages of polishing rice is to enhance its keeping properties. It is known that paddy will keep satisfactorily until milled. Husked rice, I have found, will keep in good condition for at least 2 to 3 months provided it is kept dry and access to air is allowed. This is saying that as we teach our people to keep their houses in better condition, we can expect to keep our husked rice better.

If the moisture content is high, then probably the paddy should be polished, but if rice whose moisture content does not exceed about 14 per cent. can be produced, then that rice need not be polished even though it is required to be kept for some time before consumption. Husked rice has been kept for long periods in Singapore in metal bins whose lids have been made of wire netting. This keeps out vermin, but does not exclude air. Any suspicion of weevil or mould may be corrected by exposure to the sun in flat trays. It is my experience that husked rice is not more difficult to keep than polished rice and that polished rice is just as liable to attack by weevil.

Another point which should be attended to is cooking. When husked rice is boiled the amount of water employed should be nearly half as much again as would be used when boiling polished rice. The time of boiling must also be extended by five minutes. Thus our 2,200 calories (21 oz.) of husked rice take 20 minutes to boil as against 15 minutes when boiling polished rice and 1,400 c.c. water are required for the husked rice as against 1,000 c.c. for the same quantity of polished rice. These times and amounts of water give the same consistency and degree of softness in the two cases. It is of course necessary to impress this on people who are accustomed to cooking polished rice as otherwise they would fail to produce a dish of husked rice which would be palatable to them.

Attempts have been made in my laboratory from time to time to carry out experiments in which the rice has been partly polished, *i.e.*, "under-milled". Such attempts have not been successful and the under-milled or partially milled cannot be recommended.

Thus, in addition to merely physiological propaganda, education must be given as to keep husked rice, before it can be expected that the people will make a change in the rice to which they have become accustomed. A small amount of propaganda has caused husked rice to become available in small quantities in Singapore, but much intensive propaganda spread over many years would no doubt be needed to make its use general. Husked rice has been used in certain institutions and could be employed with advantage in many more.

The whole point seems to be that we realize the importance of improving the physiological value of the diets of the people, and that this must be done without a great increase in the cost of the daily food. It seems clear that the only way of achieving this is to face the difficulty of changing the rice to a rice which is not polished.

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India's Agricultural Resources*

BY

W. Burns, C.I.E., D.Sc.

(*Agricultural Commissioner with the Government of India*)

India's agricultural resources are determined by her geography, climate and soil. Some idea of the interaction of these might be got from a relief map, on which the main soil differences were represented, and on which (perhaps by some electrical device with coloured bands of light) there could be represented the march of the seasons as to temperature and rainfall.

At this time of the year (October) we are at the end of the most momentous annual event in India, the monsoon, which is the dominant climatic factor in Indian agriculture. Over the greater part of India most of the rainfall occurs between the months of June and October, *i.e.*, in the hot months of the year, the winter being comparatively dry.

The intensity of the rainfall in any given place is determined mainly by the position of the big mountain ranges. There is a block of country in northwest India which gets little or no rain, and there are precarious areas in various parts of the Peninsula proper, where rainfall may be good in some years and bad in others.

India's Seasons

Conforming to the rainfall, there are two main cropping seasons, the *kharif* or rainy season, when crops are sown some time in June or July and harvested from October till December, and the *rabi* or cold weather season when crops are sown in September or October and harvested from February to May. There are certain crops of longer duration which are sown at some time in the rains and harvested well on in the cold weather, *e.g.*, certain kinds of cotton and groundnut.

This simple scheme, however, does not by any means cover the whole of India. In parts of south of India, there is also rain from the "return" monsoon in the period, November to February, and two or even three crops of rice may be taken in such circumstances. In such an area the division of the year into *kharif* and *rabi* does not hold. In parts of North India there is also rain in the form of occasional storms between November and February.

Generally speaking, Indian agriculture is peasant agriculture, the holdings being small, often fragmented and largely worked by the

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* Reproduced from *The Resources of India*, Supplement, *The Times of India*, October 25, 1940.

peasant and his family. The bullock is the principal working animal, while the she-buffalo is the main milk animal. Male buffaloes are used as work-animals in some places, particularly in heavy rainfall areas. This, then, is the setting for the growing of India's crops, of which we may now consider a few in detail:

Cotton

India ranks as the second cotton-growing country in the world, the United States of America holding the first place. The following table gives the all-India area in acres, and all-India production in bales of 400 lbs. each for the past ten years:—

Year	Acreage (000 acres)	Bales (000 bales)
1930–31	23,439	5,192
1931–32	23,494	4,003
1932–33	22,151	4,618
1933–34	23,692	5,057
1934–35	23,515	4,797
1935–36	25,444	5,867
1936–37	24,759	6,234
1937–38	25,746	5,722
1938–39	23,482	5,076
1939–40	21,356	4,942

The cotton produced is of many different types and its cultivation is scattered over many parts of India and not located in one belt as in America. The Bombay Province has about 30 per cent. of the total area in India, but even within that Province conditions are so diverse (largely due to its being a long narrow Province stretching over several degrees of latitude) that it contains no less than four distinct cotton-growing tracts, each with its own kind of cotton.

Cotton is a very old crop in India. Some time ago, archæologists, digging at Mohenjo-daro in Sind, about 200 miles from Karachi, unearthed a small piece of fabric which proved to be cotton. The civilisation to which this fabric belonged dates about 3000 B.C. Travellers from the Greeks to Marco Polo have described India's cotton cultivation, and there are many types of cotton indigenous to India.

In addition about 1840 there was an import of American cotton seed (with American planters to grow it) from which seed some of the American varieties now in this country have been derived, or indirectly and tried with varying success, one of the successes being Cambodia cotton imported from the French territory of that name. The following table shows the distribution of the Indian cotton crop for the year 1939–40, classified according to length of staple and shown under some of the names by which these types are known to the trade in India:—

Indian cotton crop of the 1939–40 season classified according to staple length (from Statistical Leaflet No. 1, 1939–40, Indian Central Cotton Committee).

	Bales of 400 lbs. each (Government official forecast)
Long staple—over 1 inch (Punjab-American 289 F, including 289 F/K 25 and K 23	66,000
Medium staple A—1 inch (including Punjab–American 289 F/43, Sind Sudhar, part of 1027 A.L.F. and part of Cambodia, Co. 2)	2,42,000
Medium staple B—7/8ths to 31/32nds inch (including part 1027 A.L.F., Part Cambodia, Jaywant, Punjab-American L.S.S. & 4 F, etc.)	1,576,000
Short staple A–11/16ths to 27/32nds inch (including Salems, Dharwar-Upland, C.P. No. 1, Oomras, Hyderabad Kumpta and Upland, Banilla, etc.) ..	8,43,000
Short staple B–9/16ths to 21/32nds (including C.P. Nos. 2 & 3, Oomras, Khandesh Oomras, Barsi and Nagar Oomras, Dholleras, etc.)	1,240,000
Short staple C–17/32nds and below (including Bengals from the U.P., Rajputana, Sind and the Punjab, also Comillas)	1,017,000
TOTAL ..	4,984,000

It will be seen that the long staple and medium staple types are to be found in the Punjab and Sind. These types are of American origin and have been greatly improved by the efforts of the cotton breeders of the agricultural departments of these two provinces assisted by generous subventions from the Indian Central Cotton Committee. In these areas cotton is an irrigated crop, the water for this irrigation being derived from the highly developed systems of the Punjab or from the more recent Sukkur Barrage in Sind. The cotton of these types being suitable for higher counts has a substantial

demand in Indian mills and a ready export market. An attempt to produce something still better is on the way, in the shape of a research financed by the Indian Central Cotton Committee and located in Sind, for the breeding of still longer staple cotton varieties suitable for that area. Suitable cottons from all over the world are being collected for use either in selection or hybridisation in this work.

The increase in the production of Punjab-American cotton in the last six years is shown in the following table:—

TABLE

Year	Production of Punjab-American (000 bales) Government forecast
1933–34	10
1934–35	Not available
1935–36	20
1936–37	47
1937–38	54
1938–39	72
1939–40	66

At the other end of the scale is an area of indigenous types comprising the Central Provinces, Berar, Khandesh, Central India, parts of the United Provinces and of Rajaputana in which the main cotton produced is of short staple. About a million bales of this is consumed annually in India. The biggest outside customer for this cotton has been Japan. In this area also, and particularly in the Central Provinces and Berar and in Khandesh, the plant breeders have been successful in producing types (*e.g., Verum* 434 in the Central Provinces and *Jarilla* in Khandesh) which are in the 7/8ths class and which if spread will go a long way to reduce the dependence of this tract on so short a staple.

The shortness of staple of this area is to some extent connected with the fact that the cotton is grown on the rainfall, and that the season is of short duration. There are however other parts of India where cotton grown only on the rainfall attains quite a respectable length and some of the finest and best of the indigenous cotton varieties (improved of course by the plant breeders) are to be found there. Such is the 1027 A.L.F. cotton grown in the Surat District of the Bombay Province and in the Baroda and Rajpipla States and

the *Jaywant* cotton of the south of Bombay Province. In such areas also are to be found some of the American cottons such as the Dharwar-American (also in the south of the Bombay Province) and the Cambodia in Madras.

The all-India average yield of cotton per acre though it has been considerably improved through the efforts of the plant breeders in the last ten years, is still relatively low (104 lbs. per acre in the five-year period 1933–38).

Jute

This important fibre crop is found only in one part of India. Bengal produces about 90 per cent. of the crop and the rest is to be found in the adjacent provinces of Bihar, Orissa and Assam. The crop is an old one in Bengal, but a comparative newcomer in Assam, where however it tends to increase.

The following table shows the annual area under jute in acres and the annual production in bales (of 400 lbs.) for the last ten years with the amount exported annually:—

Year	Total acreage (000 acres)	Total production of bales (000 bales)	Amount exported raw jute (000 bales)
1930	3,492	11,205	3,472
1931	1,862	5,542	3,287
1932	2,143	7,072	3,153
1933	2,517	7,987	4,190
1934	2,670	8,500	4,213
1935	2,181	7,215	4,318
1936	2,886	9,611	4,598
1937	2,889	8,656	4,183
1938	3,165	6,819	3,870
1939	3,119	9,635	3,209

(It may also be mentioned that in 1926 the jute area was just under 4,000,000 acres and the production was estimated at 12,000,000 bales.) Export figures prior to 1937 include Burma also.

Jute is peculiar in its climatic requirements, its cultivation and its economics. It is sown between February and May and takes from three to four months to reach maturity, when it stands a solid mass of vegetation, six to ten feet high. It needs damp soil and a warm

wet weather and when well established, does not mind a certain amount of waterlogging.

At flowering time the stalks are cut, tied into bundles after removal of the leaves, and left to soak in water, the so-called "retting" process. After two or three weeks the fibre is removed from the decaying matter of the stalk, washed and dried. All this is done by hand, in conditions of damp and heat, the workers often standing in water for hours.

This ends the production process, then comes the marketing, and light has just been shed on what happens between the time when the fibre leaves the peasant and the time it reaches the mills in a Report on the Marketing of Jute, just published by the Indian Central Jute Committee (obtainable from that Committee, Hastings Street, Calcutta, price Rs. 1–8). Most of the important industrial countries used to figure as purchasers of raw jute, Great Britain and Germany being the chief buyers.

Oil Seeds

Of oil seeds there are several, groundnuts, linseed, then the group that includes rape and mustard, then castor, sesamum, and cotton seed.

Groundnuts, which now rank so high among the Indian oil seeds are not indigenous. It is not exactly known when and whence the crop was introduced. It has various Indian names, most of them (like the European names) indicating its habit of burying its fruit but one of the names suggests a Chinese origin. The province which produces most groundnuts is Madras, the next being Bombay. Figures of the whole of India for the last ten years are given in the following table:—

Year	Acreage (000 acres)	Production (000 tons)
1929–30	5,177	2,180
1930–31	6,014	2,592
1931–32	5,081	2,151
1932–33	6,887	2,846
1933–34	7,586	3,186
1934–35	5,141	1,740
1935–36	5,197	2,114
1936–37	6,663	2,714
1937–38	8,898	3,501
1938–39	8,506	3,219
1939–40	8,112	3,002

There are various types of groundnuts of which the following are the chief: Mauritius, Big Japanese, Small Japanese and Spanish Peanut. The present war has hit the groundnut grower on account of loss of markets and prices have slumped in consequence, both for the seed and the cake.

Linseed occupies annually about 3,500,000 acres chiefly in the Central Provinces, the United Provinces and Bihar, though there is a good deal of cultivation scattered over other parts of India. In the Crop Planning Conference held in India in 1934 this was one of the few crops the expansion of which was definitely recommended. India is a country in which it is often the practice to grow mixed crops, *i.e.*, more than one crop in the same field, not usually mixed higgledy-piggledy but a certain number of lines of one and then a certain number of lines of another. This is to some extent an insurance against the vagaries of the rainfall, since one of the crops at least is likely to come through. Linseed is often grown in this fashion making accurate estimate of total area far from easy. A valuable source-book on the whole linseed question is the report on the marketing of linseed in India issued by the Agricultural Marketing Adviser in 1938 (obtainable from the Manager of Publications, Delhi, price Rs. 1–4).

The following table shows the acreage and production and amount exported for the last ten years:—

Linseed

Year	Acreage (000 acres)	Yield (000 tons)	Quantity exported (000 tons)
1929–30	2,802	380	248
1930–31	3,009	377	257
1931–32	3,309	416	120
1932–33	3,299	406	72
1933–34	3,261	376	383
1934–35	3,410	420	240
1935–36	3,457	388	165
1936–37	3,677	420	296
1937–38	3,890	461	226
1938–39	3,869	442	318
1939–40	3,713	467	..

Although the acreage and production figures are for India proper, the export figures prior to 1937–38 include Burma also.

There is an important group of oil seeds belonging to the mustard group and mainly grown in North India. We need not go into the botanical differences between these. Taking them as a whole, rape and mustard cover annually about 6,000,000 acres and yield about a million tons of seed. The oil is put to many uses and is first class culinary oil. The crushing of the seed is done both in small village installations and also in modern factories. The oilcake is an important cattle food. There used to be a large export of these seeds, amounting sometimes to as much as half of the total production, but with the exception of the type known as *toria,* the whole production is now consumed in India.

Castor seed comes from a plant that grows easily in many parts of India. It is tough in constitution and seems to stand up to all kinds of climate. It is found in Sind, an arid area, but it was also the crop which did best in lands recovering from the big floods in the Gujerat Division of the Bombay Province some years ago. The Nizam's Dominions has the biggest share of the castor area in India and here is located a research scheme financed by the Imperial Council of Agricultural Research, for the improvement of the yield and oil content of the crop. The all-India figures for acreage and yield for the last ten years are as follows:—

Year	Acreage (000 acres)	Yield (000 tons)
1929–30	1,285	116
1930–31	1,457	120
1931–32	1,583	146
1932–33	1,617	151
1933–34	1,534	143
1934–35	1,448	105
1935–36	1,438	121
1936–37	1,409	128
1937–38	1,148	104
1938–39	1,199	111
1939–40	1,009	94

There used to be a large export of castor seed but this has diminished considerably in recent years as the following figures show:—

Year	Exports (seed) tons
1933–34	81,559
1934–35	68,749
1935–36	59,968
1936–37	43,089
1937–38	42,079
1938–39	7,621

The export figures prior to 1937–38 include Burma also.

India is, therefore, using within her borders more and more of the crop produced. The cake is a valuable manure and has at the present moment not suffered the price slump which has hit groundnut cake.

The position regarding cotton seed is that there is a large production but little export. The figures of export for the last ten years are as follows:—

Year	Cotton seed exported quantity (tons)
1930–31	41,350
1931–32	11,655
1932–33	2,389
1933–34	5,575
1934–35	636
1935–36	730
1936–37	9,003
1937–38	5,008
1938–39	465

Exports of cotton seed prior to 1937–38 include Burma also.

Cotton seed is used very largely in India as a cattle feed. There are also one or two mills which crush the seed and produce cotton seed oil.

Wheat

Wheat is mainly produced as an irrigated crop in the Punjab, Sind and the United Provinces. There is also an important but much smaller area in the black soil area in the Central Provinces and part of the Bombay Province where *durum* wheats are grown, as a rain-fed crop. The following table gives all-India acreages, yields and exports for the past ten years:—

Year	Acreage (000 acres)	Yield (000 tons)	Export (000 tons)	
			Wheat	Wheat-flour
1929–30	31,654	10,469	13	51
1930–31	32,189	9,306	197	47
1931–32	33,803	9,024	20	43
1932–33	33,976	9,455	2	21
1933–34	36,077	9,370	2	13
1934–35	34,490	9,729	11	12
1935–36	33,639	9,434	10	18
1936–37	33,215	9,752	232	24
1937–38	35,640	10,764	450	62
1938–39	35,291	9,934	279	61
1939–40	34,003	10,784	..	..

Whereas the acreage and yield figures are for India proper, the exports prior to 1937–38 include Burma also.

Exports of wheat from India takes place only when the world price is relatively high. At one time during 1914–18 War the exports reached 1,700,000 tons in a year.

The wheats grown in the Punjab, Sind and the United Provinces are of the bread type. The plant breeders of the agricultural departments have devoted much time to the improvements of these wheats with conspicuous success. In the Punjab two recent winners are C. 591 and C. 518. Unlike the state of affairs in some of the other wheat-producing countries of the world, Indian wheat production is not mechanised. This crop was the subject of the first of the reports of the Agricultural Marketing Adviser (*Report on the Marketing of Wheat in India*, 1937, obtainable from the Manager of Publications, Delhi, price Rs. 1–4). This is a useful source-book not only as regards marketing but also on many other aspects of the crop.

Rice

In no crop is India's "infinite variety" so clearly shown as in her rices. Equally variable are the ways in which rice is grown. At the one end of the scale we have the deep-water rices of Assam which elongate as the flood rises until the stalk may be 8 feet long. At the other end we have, in the Baroda State and parts of the Gujerat Division of the Bombay Province, rice varieties which are grown in the same field as and in alternate lines with cotton, *i.e.*, as a crop grown on the rainfall without any flooding whatever.

Over the greater part of India, rice is grown in flooded fields. In these the rice is either broadcasted or transplanted, the transplanting of rice being done from carefully prepared nursery beds, and it is the transplanted rice that gives the highest yields.

Rice may be irrigated, as in Sind or Madras, or grown on the rainfall only as Bombay and Bengal. Generally speaking, a rainfall of fifty inches and above is required for the growing of rice without irrigation. The following table shows the area and output of rice in India for the last ten years:—

Year	Acreage (000 acres)	Yield (000 tons)
1929–30	67,619	26,146
1930–31	69,663	27,055
1931–32	71,745	28,799
1932–33	69,960	26,201
1933–34	70,340	25,733
1934–35	69,731	25,706
1935–36	70,998	23,213
1936–37	72,295	27,828
1937–38	72,568	26,702
1938–39	73,375	23,915
1939–40	72,340	25,257

Compared with the average yields of some other rice-growing countries the Indian average may appear small, but in favourable conditions and particularly when given suitable manuring (particularly green-manuring) yields in India of 3,000 lbs. to 4,000 lbs. per acre are obtained. Yields have also been improved by the production in all rice provinces of better varieties through the activities of the plant breeders.

The rice grower in India has one or two curious difficulties to contend with. One of these is the presence in certain areas of wild rice. The earhead of wild rice has the habit of "shattering", *i.e.*, breaking up while still on the plant, this being its way of sowing itself. Wild rice easily crosses in nature with cultivated rice and unfortunately passes on to the hybrid this bad habit. The breeding of rices which have some colour which enables them in the seedling stage to be differentiated from the wild rice permitting the elimination of the latter, is one of the likely lines of advance.

Land crabs are another pest of rice. These bore holes in the embankments of the rice fields and so let the water out. Various remedies such as baits, poisoning and gassing have been tried, but the problem is not yet entirely solved, particularly as regards cost. The main rice-eating provinces are Bengal, Bihar, Orissa, the Central Provinces and Madras. In the United Provinces wheat is of equal importance. In Bombay the millets have also a food importance.

Sugar

The area and output of sugarcane increased after the grant of fiscal protection to sugar which has been in operation since the year 1932.

Year	Acreage (000 acres)	Gur Yield (000 tons)
1929–30	2,513	2,752
1930–31	2,801	3,228
1931–32	2,971	3,975
1932–33	3,317	4,676
1933–34	3,311	4,896
1934–35	3,481	5,140
1935–36	4,024	5,931
1936–37	4,440	6,476
1937–38	3,869	5,403
1938–39	3,113	4,108
1939–40	3,766	4,733
1940–41	4,215	

Indian sugarcane varieties have been greatly improved particularly by the efforts of the plant-breeders at Coimbatore and the canes with

the initials Co., followed by a number, are now known and many of them planted, not only in India but in many other sugarcane growing countries. The original intention of the Coimbatore station was to breed canes for Northern India, and in this it has been successful. It has also produced canes which suit tropical India, and canes for this part of the world have also been produced by the Mysore plant breeders. As much as 75 per cent. of the sugarcane area in India is now covered by improved canes a condition of things not even distantly approached in any other crop in India.

India has some wild sugarcane species and the "blood" of these has been incorporated by hybridisation into some of the improved canes, thereby giving them toughness or constitution and resistance to adverse conditions.

Sugarcane is crushed in small bullock-driven mills for the production of a substance known in different parts of the country as *gur, gul* or jaggery. This is produced by boiling the expressed juice in a big shallow iron pan (or series of pans) over a crude furnace usually with the addition of some clearing agents which enable impurities to be skimmed off, and then pouring the brown thick fluid at just the right stage into moulds where it solidifies.

Gur production still accounts for the greater part of the sugarcane grown in India, and *gur* is an important part of Indian food. It varies greatly in colour, consistency, taste and keeping qualities. Recently in some places activated carbon has been used to give a very high quality *gur*.

There is also the use of sugarcane for the indigenous sugar industry, making the so-called *khandsari* sugar. This again is a small-scale industry but normally requires some source of power for the driving of the centrifugals. The amount of *khandsari* sugar produced annually in India is of the order of 1,25,000 tons.

The improvement of sugarcane cultivation, the study of its pests and diseases, and the investigation of its physiology are being carried out at a chain of research stations throughout India, also at the Imperial Agricultural Research Institute at New Delhi and its sub-stations, and with the collaboration of many factory *estates*, while the technological side is looked after by the Indian Institute of Sugar Technology at Cawnpore.

Pulses

India has a great range of pulse crops. These pulse crops are important both from the point of view of husbandry and of nutrition. They are an invaluable phase in many rotations, helping to keep up the fertility of the soil, which purpose they also perform when grown (as they often are) as mixed crops, particularly with millet, the

millet ripening and being harvested first. In the realm of nutrition they are sources of protein, particularly necessary in a country where the bulk of the population is vegetarian. They are also important from the point of view of animal nutrition, to which they contribute in a variety of ways, *e.g.*, by their seeds, by their hulls, and by the green parts of the plant. Gram and *tur*, also called *arhar* or *rahar*, are probably the most important and most widely grown. The annual areas and yields of gram for the years 1929–30 to 1937–38 are as follows:—

Year	Acreage (000 acres)	Yield (000 tons)
1929–30	13,175	3,051
1930–31	15,223	3,400
1931–32	17,735	3,766
1932–33	15,803	3,439
1933–34	18,443	3,737
1934–35	15,638	3,629
1935–36	16,687	3,840
1936–37	17,626	4,115
1937–38	15,742	3,525

Millets

The most important of the millets is the great millet known over a great part of Northern and Central India as *Jowar*. In Southern India it is called *cholam* or *jola*. This is the sorghum of America. India is peculiarly rich in *jowar* varieties which centuries of natural and human selection have adapted to all sorts of conditions and purposes. Many of the jowars produce food for both man and beast, the grain being used for men and the dried stalks (known over a great part of India as *Kerbi*) being cattle feed. There are also varieties which produce little grain but sweet succulent stalks and which are grown as green fodder. Some varieties are adapted for the *kharif* and some for the *rabi* season.

In India, as in Africa, this millet suffers in some places from the little flowering parasitic plant botanically known as *Striga* (in Africa called witchweed), and work is in progress at Poona and elsewhere to find varieties resistant to this pest. Breeding of better varieties is being done in various centres of agricultural research chiefly in the Punjab, Madras and Bombay.

The next most important millet is known in Northern and Central India as *bajri* or *bajra,* in South India as *cumbu.* In other countries this is often called pearl millet. The head is like that of a bulrush and the grains are small and with pearly lustre. *Bajri* is a crop which tolerates poorer soils and smaller rainfall than jowar. Like jowar, its grains are used for human food and its stalks as fodder. The grains of both millets are regarded as having higher food values than rice. The areas and yields under each of these for the last ten years are as follows:—

Year	Acreage (000 acres)	Yield (000 tons)
	Jowar	
1929–30	35,236	6,878
1930–31	35,173	6,928
1931–32	33,887	6,149
1932–33	33,449	6,412
1933–34	32,167	6,138
1934–35	33,478	6,255
1935–36	32,825	6,159
1936–37	37,220	7,098
1937–38	33,489	6,506
1938–39	33,812	6,435
	Bajra	
1929–30	17,271	2,284
1930–31	19,524	2,583
1931–32	18,310	2,673
1932–33	18,699	2,598
1933–34	16,552	2,128
1934–35	17,031	2,549
1935–36	16,911	2,681
1936–37	16,013	2,433
1937–38	17,242	2,625
1938–39	17,216	2,540

There are one or two other crops of the millet group, some of them being what look like only partially domesticated grasses, but one is worth mentioning, namely, *Eleusine coracana* (known as ragi). This has a very small grain and occupies poor lands in areas that otherwise grow rice. Some plant-breeding work has been done on this species in Bombay, Madras and Mysore and it has its place in the agriculture of certain area.

Fruit

It is not easy to give an accurate picture of fruit growing in India as statistics are deficient and the actual growing is seldom in large solid areas. The total area under fruit is probably between three and four million acres. There is a great diversity of fruits grown in India among which may be mentioned mangoes, oranges of various kinds, pomeloes, grape-fruits, papayas, figs, bananas, guavas and some less known fruits such as the chiku (the sapodilla plum), the litchi, and the custard apple.

In the north, where there is a cold winter, we find apples, pears, peaches, quinces, plums, cherries and grapes. Kashmir is noted for its apples, also certain portions of the lower hills in the Punjab and the United Provinces. Some gifts of nature (aided perhaps by the Portuguese or other early gardeners) such as the Alphonso and some other varieties of mango are extraordinarily good, but generally speaking, there is a lot to be done in the improvement of the quality of Indian fruits. Investigations with this end in view are in progress at a chain of fruit research stations throughout India, and next month a conference of the workers at these stations is being called in Delhi by the Imperial Council of Agricultural Research.

The marketing of fruit has also been the subject of investigation by the Agricultural Marketing Adviser. The canning of fruit and the bottling of fruit juices has for several years been under study, particularly at the Punjab Agricultural College, Lyallpur. Fruit canning has not yet developed very far, though there are one or two companies whose products are on the market, but the bottling of fruit juices has gone ahead in certain areas particularly in the Punjab. Experiments are also being made with the drying of fruit in North-West Frontier Province, in Baluchistan and in the Punjab.

Fibres

Mention has already been made of cotton and jute. In addition India produces no small amount of the so-called sunn hemp (*Crotalaria juncea*). This plant is also extensively used as a green manure, particularly for sugarcane. The area grown for fibre is about 600,000 acres annually and annual exports amount to about 800,000 cwt.

Another fibre plant widely grown is *Hibiscus cannabinus* (known by various names such as ambadi, mesta pat, and Bimlipatam jute). This is of more local importance. It should be mentioned that both fibres are used for making ropes and twine for village use in India.

The rozelle which is now being grown in the Netherlands Indies as a fibre plant, grows easily in India, but its cultivation is small and scattered and, where grown, it is generally cultivated for its succulent calyx from which a preserve can be made. Throughout India the traveller will often see plants of *Agave* (often wrongly called aloes) grown particularly as a fence on certain railway lines. The sisal hemp, *Agave sisalana*, which belongs to this group, has been tried more than once in India, and, given suitable conditions, can do quite well, but no large sisal plantations exist.

Flax was the subject of experiment from 1906 till about the end of the last War and is again being tried.

Soyabean has been experimentally grown in every province and many States in India, but has never taken hold in the agriculture of the country on account of the lack of a market and the fact that, except in certain limited areas, the bean is not appreciated as food.

This brief survey naturally leaves a great deal unsaid and many questions unanswered but may perhaps give a rough idea of India's agricultural background.

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